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Planning needs assessment for responding to large disaster events in cities: case study from Dhaka, Bangladesh

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Abstract

Earthquakes happen without warning. Although urban communities are quite capable of responding to frequent disaster events, there is a need for conducting advanced contingency planning to handle extreme events. One reason for conducting contingency planning is to facilitate a rapid emergency response by allowing planners to have more time for advanced preparedness measures. Before an earthquake emergency, planners will be able to consider different risk scenarios in order to develop a coordination structure, identify spatial planning needs for reducing the risk, consider likely post disaster needs, conduct capacity assessment to identify the key resource requirements (both human and physical), identify the critical gaps for immediate action, and define the policy changes/revisions, new strategies and approaches for responding to large city-level emergencies.

This paper evaluates the potential earthquake risk scenario in Dhaka city (Former Dhaka City Corporation which was divided respectively into Dhaka North and South City Corporation in 2011), and discusses the planning needs that are required for capacity enhancement in order for the city respond to large-scale disasters such as earthquakes.

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1. Introduction

The rapid increase in vulnerability to natural hazard events within urban areas is evident from recent disaster events. Vulnerabilities are triggered by rapid urbanization, population growth, population migration, and an increase in economic opportunities due to development of major economic zones around major cities in Asia. Demand for appropriate policy approaches have been discussed for quite some time in regards to preparedness planning and program implementation for abating increases in disaster vulnerabilities, in order to build disaster resilient urban communities. However, present capacities in disaster management are largely centered on emergency response and post disaster recovery of frequent recurring events in many countries. The lack of capacity for managing low frequency yet high magnitude rare extreme events, is evident from recent devastating events recorded around the world. Thus, there is a need for a comprehensive geo-hazard risk reduction "Contingency Planning" strategy for managing high magnitude events such as earthquakes, which occur without warning.

It is extremely important to anticipate as effectively as possible, the future potential earthquake threats in hazard-prone countries, especially probable impacts on cities and urban centers due to high vulnerability. Further, there is a need for planning better response as well as quick and early recovery in the future. The space dependency of the impacts of earthquake hazards, comprehensive risk and vulnerability assessments to analyze the spatial distribution of such vulnerabilities, and potential risk elements across the cities are also essential. It is necessary to build damage scenarios for assessing the response needs and preparedness capacity, and to use the same databases for subsequent contingency planning processes. Time becomes more valuable once an emergency occurs, so comprehensive planning before the emergency is essential, when workloads may be less and institutions involved are more flexible in accommodating needs.

2. The need for effective response mechanism for resilience building at city level

An emergency is any situation in which the life or wellbeing of a community is, or will be, threatened unless immediate and appropriate action is taken to manage the situation. Usually emergency events demand extraordinary responses and exceptional measures. Time constraints, enormous needs and complex coordination are the three issues that need to be managed well in order to bring any emergency event under control. The higher the magnitude of the event, the more complex the coordination mechanism becomes, the greater the needs become, and time becomes a very limited commodity.

The contingency plan serves as a tool for maintaining control over and above these three issues. It helps in facilitating effective management of an emergency event and limits the risk of losing control in managing the event. Due to the scale of the problems that a high magnitude emergency such as an earthquake can produce, sometimes that sort of event also may provoke erratic or unpredictable responses. Unless there is an accepted plan developed in advance, less-equipped agencies or incompetent personnel overreact to emergencies making things more complicated. The risk of inappropriate responses is much lower when clear plans are in place. The contingency planning process also allows for the identification of projected needs that may arise as a result of an emergency and the resources that will be immediately required to meet those needs. One other benefit of a realistic contingency plan is that it may encourage external parties such as donors, humanitarian agencies, international NGOs, UN agencies etc. to help in mobilizing the needed resources without much delay.

Although the objective of contingency planning is usually the production of a contingency plan, many useful outputs of contingency planning come from the plan development process. There are many advantages in a plan prepared by stakeholders through a participatory process, agreeing on the broad policies and an agreeable coordination framework. Even though the earthquake that occurs may be very different from the one planned for, the plan will still be useful. A good contingency plan ensures better preparedness for any emergency that may occur, even one that is very different from the scenario envisioned.

Soon after any emergency, needs will be much higher than the existing capacity of institutions, whereas the capacity may drop considerably due to damages to existing facilities. For example, hospital buildings may get damaged during an earthquake but there will be a higher need for medical emergency assistance. The contingency planning framework will have to address such anticipated challenges that can arise during emergencies.

3. Functional cluster framework for effective earthquake response at city level

Typically, many government and non-government agencies are involved in accomplishing response activities after an earthquake occurs. However, experiences have shown that these response activities are extremely complicated and no single agency alone can perform any of the response activities fully. All related organizations have to work together in a coordinated manner so that their capacities and resources are best utilized to fulfill the requirements complimenting and supplementing each other. Realizing the need for coordinated and comprehensive emergency response, United Nations agencies have been promoting its humanitarian response activities in a cluster approach as per the guidelines issued by Inter-agency Standing Committee (IASC). These Inter-agency contingency planning guidelines for humanitarian assistance have been made available in 2007 and several modifications have been issued in subsequent years.

This approach proved to be effective and efficient in responding to some of the large scale disaster events. This was evident from the response efforts in the October 8, 2005 earthquake in Pakistan. In this approach, anticipated response activities were identified early, and when clustering them into functional groups, attempts were made to identify institutions responsible for each activity. Activities were grouped into functional clusters based on similarity of works, normal time and disaster time mandates of different responder organizations and build possible complementarity in the resources and capacities. Identifying lead and support institutions along with global cluster leads were necessary for easiness of operations, maintenance of the command and control structure, and to undertake training and capacity building by fixing the accountability to lead agencies in each cluster.

Contingency plans by nature examine specific risks within a given urban area and outline a comprehensive approach that clearly identify the agencies responsible for particular actions across pre, during and post disaster periods. It also helps to generate a number of scenario-based problems, specific to an area in order to test the capacity for response. Consequently, clustering provides an opportunity to reflect on how operations will be conducted within a particular area, indicating current conditions that the plan operates.

The response activities, as well as the contingency planning, should be coordinated and performed on a cluster system. This approach is more useful when cluster level spatial databases can be developed, identifying available facilities, infrastructure, resources etc. for each respective functional cluster. The earthquake risk scenarios for any city generated through the risk assessment process provides the scenario after an earthquake of different magnitudes, and response needs can be compared with the existing resource base to ascertain the adequacy of existing resources. This sort of analysis of capacity on a cluster basis is expected to provide useful information for designing an efficient and orderly earthquake response management mechanism for the respective city.

The earthquake response management mechanism will indicate redundancies in resources as well the additional resources necessary to acquire and keep as standby facilities. In addition, such analyses would also provide useful planning information for pre-positioning of facilities (such as mobile hospitals, water supply tube wells, stand by generators etc.), to ensure uninterrupted functioning of urban services.

4. Case study on contingency planning with regard to earthquake hazard in Dhaka city

Bangladesh is susceptible to damaging earthquakes. Though during the recent past no major scale earthquake events have occurred in Bangladesh or within its neighborhood, records indicate that during the past few hundred years there have been several significant earthquake events recorded within Bangladesh.

4.1. Project on City level Contingency Planning with regard to Earthquake Hazard

The project on “Contingency Planning with Regard to Earthquake Hazard” in Bangladesh has been implemented under the Earthquake and Tsunami Preparedness component of the Comprehensive Disaster Management Programme (CDMP) Phase 1 (2007-2009). The CDMP is a five-year program implemented by the Ministry of Food and Disaster Management of the Government of Bangladesh, jointly funded by UNDP, DFID and EC. ADPC has prepared scenario-based Earthquake Contingency Plans at three different levels: national, city (for Dhaka, Chittagong and Sylhet cities) and agency levels.

4.2. Earthquake Risk scenario for Dhaka, developed under Phase 1 of CDMP

Under CDMP-I, the earthquake risk assessment of Dhaka City Corporation areas was carried out using HAZUS model for analyzing potential damages and losses from different earthquake scenarios. HAZUS is a regional loss estimation model that was developed by the United States Federal Emergency Management Agency (FEMA) and National Institute of Building Sciences (NIBS).

Considering the likely earthquake threat in Bangladesh, the following three different scenarios (see table 1) have been developed to identify the possible damage to buildings, infrastructures, utility services, facilities etc., as well as the number of casualties (see table 2 and 3).

Table 1. Selected earthquake scenarios.

Scenario	Description
Scenario-1	An earthquake at 7.5 Mw originated from Madhupur Fault
Scenario-2	An earthquake at 8.0 Mw originated from Plate Boundary Fault-2
Scenario-3	An earthquake at 6.0 Mw originated from beneath of the city

Table 2. Expected damage to buildings in Dhaka City Corporation area due to three selected scenarios.

Scenarios	Number of Building Damage		
	Moderate	Extensive	Complete
Scenario-1	53,166	33,153	72,316
Scenario-2	34,326	13,480	45,609
Scenario-3	15,343	19,097	238,164

Table 3. Number of injured and killed.

Severity level	2:00 PM (Day-time)	As a % to the total population	2:00 AM (night-time)	As a % to the total population
Number of people will be killed immediately after the earthquake	131,029	1.82	121,815	1.70
Number of people will require hospitalization and can become life threatening if not promptly treated	25,905	0.36	21,355	0.30
Number of people will require hospitalization but are not considered life-threatening	7,043	0.10	5,287	0.07
Number of people will require medical attention like first aid or some kind of treatment	61,288	0.85	88,503	1.22

4.3. Selection of functional clusters for earthquake contingency plan for Dhaka city

The concept of response operations in functional clusters should be applied in the context of Dhaka city for a contingency plan to respond to a possible earthquake disaster. Hence, following a widely accepted inter-agency contingency planning approach adopted by the UN system and based on the existing emergency response mechanism, legislative and current institutional framework of Bangladesh, the following nine functional clusters as presented below in Box 1, have been adopted in formulating the city-based earthquake contingency plan.

The roles and responsibilities of first responder agencies, second responder agencies as well as other supporting agencies have been identified and consensus building has been carried out for defining a suitable command and

control mechanism during an earthquake. Historical evidence suggests that Bangladesh may receive a considerable volume of humanitarian assistances from foreign countries and many UN agencies, international NGOs and development partners will be involved in response operations. Therefore, when roles and responsibilities are defined, all such international agencies have been included in the proposed functional clusters. This would enable the lead agencies in each of the clusters to coordinate with international agencies in a more cohesive method during any disaster.

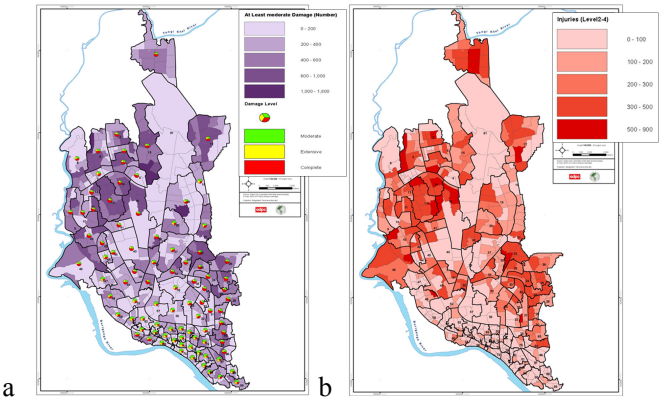

Fig. 1. Impact of probable earthquakes and loss estimation within the Dhaka city corporation area (a) Expected building damage; (b) Casualties.

5. Planning needs assessment to facilitate effective earthquake response

Considering the probability of immediate occurrence, Scenario 1 at 2:00 PM as an earthquake at 7.5 Mw originated from Madhupur Fault, is taken as the basis for estimating the resource needs and available capacities during the contingency plan preparation.

Search and Rescue

Approximately 94,434 people will likely be trapped (both in injured and dead) inside the collapsed buildings (refer table 3). Of those, some will come out by themselves, community volunteers will assist some, and some may require medium to highly specialized search and rescue assistance. As per the INSARAG Guidelines, approximately 47,217 victims (50%) can be extricated by the community themselves or with the light search and rescue teams, whereas another 50 per cent (approximately 47,217) victims will likely require assistance of specialized search and rescue teams.

Box 1. Functional clusters suggested for the earthquake Contingency Plan for Dhaka city.

- Overall Command and Coordination
- Search, Rescue and Evacuation
- Health
- Relief Services (Food, Nutrition and other Relief)
- Shelter (Including Camp Management)
- Water Supply, Sanitation and Hygiene
- Restoration of Urban Services
- Transport (Road, Rail, Air, Sea)
- Security and Welfare

The specialized search and rescue capacity mainly exists with the Bangladesh Army, Fire Services and Civil Defence (FSCD) and Bangladesh Red Crescent Societies (BDRCS). Currently, there are only 11 FSCD stations within Dhaka City Corporation area, which will be primarily responsible for conducting specialized search and rescue operations during an earthquake emergency in the city. The urban community volunteers trained by FSCD for Dhaka City Corporation area will provide all support to the specialized team for search and rescue operations.

Immediate Evacuation Spaces

It is estimated that 1,527,666 people will be displaced due to buildings collapsing. These populations will need to be evacuated immediately to the nearest open spaces. A total 4,569,346 square meters will be required (considering one square meter/person as standard) to accommodate the displaced people for immediate evacuation (assembly after the scenario earthquake). Open spaces available within the restricted areas, universities, colleges, and institutional areas are not considered evacuation spaces. Although the total capacity of available open spaces within the city is more than the required estimation for immediate evacuation, they are not evenly distributed throughout the city.

Evacuation Routes

The proposed evacuation routes that can be used for safe evacuation of the population from different areas have been analyzed. Usually, only roads with a width of six meters and above are considered "safe" for evacuation, because other smaller urban roads inside the city will likely to have higher possibilities of blockage due to road damage itself or due to falling debris from damaged buildings. However, the existing roads with a width of six meters and above within Dhaka city are not evenly distributed throughout the city and not well connected.

Fire Control

The analysis shows that a Scenario 1 earthquake will result in multiple conflagrations immediately. There will be an estimated 920 ignitions that will burn about 4.12 square miles that is 9.04 per cent of the city area. It is estimated that the fires will displace about 701,134 people and burn buildings worth of about 1,577 (millions of dollars).

In the aftermath of the earthquake and subsequent aftershocks, there will be massive requirements of response efforts from FSCD for both firefighting and search and rescue operations. The conventional response efforts and capabilities of only 11 FSCD within Dhaka City Corporation area will likely be overwhelmed.

Health Facilities

Currently, there are 59,849 hospital beds available for use in different hospitals and clinics within Dhaka City Corporation area. The Scenario 1 earthquake is likely to cause moderate to severe damage to many hospital buildings that would result in only 24,242 hospital beds (41%) being available on the first day of the earthquake. However, this total will not actually be available for earthquake victims, because some of these will be pre-occupied by regular patients. Assuming regular patients will already be occupying 50 per cent, the actual available number for earthquake victims will be 12,121. The estimates show that approximately 26,642 people will require hospitalization immediately after the Scenario 1 earthquake, hence, a total of 14,521 beds still need to be provided by alternate means (i.e. by field hospitals).

Emergency Shelters

It is estimated that approximately 1,527,666 people in the Dhaka City Corporation area will be displaced in a Scenario 1 earthquake. However, all these displaced people may not require shelters to be provided by government and relief organizations. Part of them will take shelter at their relatives' and friends' houses, or may rent out spaces in remaining buildings (undamaged for partially damaged). It is assumed that approximately 50 per cent of the displaced population will manage shelters on their own. The remaining 50 per cent of the population will require shelters provided by government and relief organizations.

The SPHERE standard for shelter provision is 45 square meters of surface area per person. However, realizing the scarcity of open spaces in Dhaka City, 45 square meters per household is used as the required minimum standard to calculate the space need for shelter. Using the average household size in the country as 4.8 persons (Statistical Pocket Book Bangladesh 2008,) the possible shelters requirement is calculated for the displaced population. Hence, a total of 7,160,400 square meters of shelter spaces for approximately 159,120 households will need to be provided by government and relief organizations.

After an earthquake, open spaces such as parks, playgrounds, recreational centers etc. are potential shelter areas for the homeless population. The open spaces available in Dhaka City Corporation area include smaller areas ranging from hundreds to thousands of square meters. The smaller spaces are appropriate only for immediate

evacuation purposes, whereas only bigger ones (larger than 25,000 square meters, which can accommodate more than 500 families) are considered as appropriate for temporary shelter purposes. Currently, there are approximately 2,278,600 square meters of open spaces within Dhaka City Corporation area, which can accommodate only 50,640 families for emergency shelter purposes. Approximately 4,881,800 square meters of additional area will be needed for emergency shelter purposes for the remaining displaced households. The locations of identified for temporary shelters are shown in Fig. 2. (b).

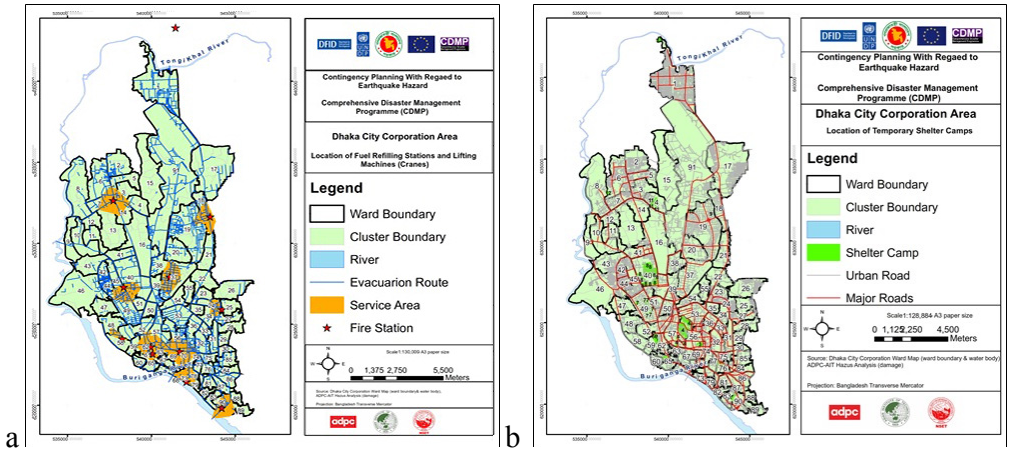

Fig. 2. (a) Location of fire service stations and their potential catchment areas; (b) Locations identified for temporary shelters

Relief Services (food, nutrition and other relief)

The requirements for food and other relief items for the people living in shelter camps in different locations of emergency temporary shelter have been calculated for daily and monthly requirements using SPHERE standards for emergencies. Based on current production in Bangladesh, four types of food items such as wheat flour, rice, lentils and vegetable oil are taken as the most common foods. These are also appropriate foods for storage and distribution during earthquake disasters.

Water Supply, Sanitation and Hygiene

Average water used for drinking, cooking and personal hygiene in any household is at least 15 liters per person per day. Likewise, for excreta disposal purpose, one toilet is required for a maximum of 20 people. Assuming this as a minimum requirement, the total quantity of water and total number of toilets required in different shelter camps will be calculated.

Transportation

One of the immediate actions related to road transportation networks after an earthquake, is to open some key roads facilitating urban search and rescue. Search and rescue equipment are necessary to transport to different locations for the effective rescue of the trapped people. The direct damage to the road network and the heavy damages to the buildings indicate that most of the roads get either direct damage or get blocked due to debris.

In Dhaka City Corporation area around 30 million tons of debris will likely be generated from a Scenario 1 earthquake. If the debris tonnage is converted into an estimated number of truckloads, it will require about 1,200,000 truckloads (at 25 tons per truck) to remove the debris.

Security and Welfare

General security for the affected area as well as emergency shelter camps also need to be provided according to

the national standards and the capacity of city security forces.

The estimation shows that during a Scenario 1 earthquake, approximately 88,503 people are likely to be killed within Dhaka City Corporation area. These dead bodies need to be managed properly at appropriate locations and as per cultural and religious norms. Plans need to be put in place for arranging funerals for the dead as per above estimates.

6. Conclusions

The overall goal of the city-level contingency planning process is resilience building through developing an advanced comprehensive geo-hazard risk reduction strategy that is linked to an easy implementation framework for responding to large scale emergencies. The framework should be able to address the current needs and issues, which would be implementable at the city level. Time becomes more valuable once an emergency occurs, so planning before the emergency is very important, when workloads may be less and institutions involved are more flexible in accommodating the needs.

This study has been undertaken to ascertain the emergency needs in case of a Scenario 1 earthquake within Dhaka City Corporation area in terms of estimated number of manpower needs, resources, spatial requirements etc. They have been identified under different functional clusters and presented. From the numbers obtained, we can clearly see the additional requirements/emergency needs that will be generated due to a Scenario 1 earthquake in Dhaka. Contingency plans need to consider how such emergency needs can be made available within a quick period after a destructive earthquake, in order to exercise an efficient response mechanism.

Such needs can be met through permanent measures and semi-permanent measures taken before an emergency, as well as with the support of other neighbouring municipalities after the emergency. There will be short and medium term solutions connected with operational and coordination issues. There will also be long term needs, which are connected with physical planning and existing land use changes. Such spatial planning requirements need to be met through specific physical planning interventions. Necessary legal and administrative regulations have to be put in place in advance. All of these measures allow constructive interventions prior to the occurrence of an earthquake emergency, as there will be comparatively more time to consider all the options and to meet challenges and likely problems if any.

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